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1. Your reference GBP87108

2. Patent application number (The Patent Office will fill in this part) 0227976.8

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P01/7700 0.00-0227976.8

3 Full name, address and postcode of the or of each applicant (underline all surnames)

Shaw, Thomas Mahon
16 Gaveway
London SW9 0AK
United Kingdom

07943245001

Muldowney-Colston, Tony Elijah
104 Mau Po Village
Lobster Bay, Clearwater Bay
Sai Kung
New Territories
Hong Kong

08517666001

Patents ADP number (if you know it)

If the applicant is a corporate body, give the country/state of its incorporation

4. Title of the invention Rotating Electrical Machine

5. Name of your agent (if you have one)
"Address for service" in the United Kingdom to which all correspondence should be sent (including the postcode)

Marks & Clerk
57 - 60 Lincolns Inn fields
London WC2A 3LS

Patents ADP number (if you know it) 18001

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Country	Priority application No (if you know it)	Date of filing (day / month / year)

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application	Date of filing (day / month / year)

8. Is a statement of inventorship and of right to grant of a patent

quired in support of this request? (Answer 'Yes' if:
any applicant named in part 3 is no ventor, or
b) ne is an inventor who is not name an applicant, or
c) any named applicant is a corporate body.
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9. Enter the number of sheets for any of the following items you are filing with this form. Do not count copies of the same document

Continuation sheets of this form	0
Description	7
Claim(s)	5
Abstract	1
Drawing(s)	5 + 2

10. If you are also filing any of the following, state how many against each item.

Priority documents	
Translations of priority documents	
Statement of inventorship and right to grant of a patent (Patents Form 7/77)	
Request for preliminary examination and search (Patents Form 9/77)	
Request for substantive examination (Patents Form 10/77)	
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11. I/We request the grant of a patent on the basis of this application.

Signature M&S + Clk Date: 29 November 2002

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GB Patent Filings
0207 400 3000

Rotating Electrical Machine

The present invention relates to rotating electrical machines, that is machines which can be used either as electric motors, in which electrical energy is converted into movement, or as electric generators in which movement is converted into electrical power.

There are two known types of DC electric motors. In the first type, a DC electrical power source is connected by means of contact brushes to coils wound on an armature arranged to rotate about, or within, a stator in the form of one or more permanent magnets or separately energised electromagnets. The rotation of the armature relative to the brushes via a commutator also serves to switch electrical current between the coils. In the second type, the rotor comprises a plurality of permanent magnets, and the stator comprises a number of coils and associated electrical circuitry which controls the switching of electrical power between the coils.

The disadvantage of the first type is that electromechanical wear of the brushes and commutator limits the lifespan of the machine to 2000 hours. Also, as only one coil at a time is energised, there are limits placed on

the efficiency of the machine. Furthermore, the sparks generated by the brushes and commutator create electromagnetic interference. The second type overcomes the three problems mentioned above, but the use of drive electronics makes the machine much more costly to manufacture than the first type.

It would be desirable to provide a motor-generator which overcomes, or at least mitigates, some or all of the problems associated with the first type of motor described above, without the extra costs associated with the second type.

In particular, it would be desirable to provide a motor-generator including only a small number of separate components which may be manufactured and assembled by mass-production techniques, and therefore one which, within the scope of manufacturing tolerances, exhibits high performance at a low production cost.

Thus, in accordance with the present invention there is provided an electric motor-generator comprising:

A rotor comprising a permanent magnet mounted on a rotating shaft;

A stator comprising a plurality of electromagnets (coils), all of which are energised at all times, except when their polarities are being switched;

A means of switching the polarities of the stator electromagnets (coils), mechanically linked to the rotor.

The first two aspects of the machine are commonly found in Brushless DC motors and are familiar to those skilled in the art.

The third aspect comprises a plurality of bipolar leaf switches, two per coil, arranged such that as the switch is moved from one contact to the other, the polarity of the coil is reversed. These switches may be activated by a cam mounted on the shaft. The cam spans 180 degrees, so that as the shaft rotates, the coils are energised half the time with one polarity, and half the time with the other. Furthermore, the cam is aligned with the permanent magnet such that the point at which the polarities are reversed is the point at which the permanent magnet is lined up with a given coil, such that as there is no change in flux linkage at that point, there is no voltage or current in the coil. The advantage of this is that as the coil carries no current at this point, there is also no spark as the

polarities are switched. This means that electrical wear is kept to a minimum, and electrical efficiency is maximised. It will be noted that the only limiting factor on the lifespan of the machine is the mechanical life of the switches, which can be engineered to be many thousands of hours.

It will also be noted that as the switches are mechanically linked to the shaft, and thus the permanent magnet rotor, there is no need for any form of position-sensing electronics or angle encoder.

Finally, it will be noted that a system of leaf switches uses less copper, and is simpler and cheaper to manufacture, than brushes and a commutator. Additionally, the contact of the leaf switches does not exhibit the rotational friction, and thus mechanical wear, associated with brushes and a commutator.

The invention thus exhibits the properties of simplicity, low cost, high efficiency and long lifespan.

Aspects of the invention will become apparent from the following description, which is given by way of example only.

Embodiments of the invention will now be described by way of example only and with reference to the accompanying drawings in which:

Fig 1. Shows the rotor arrangement, with permanent magnet, shaft and cam.

Fig 2. Shows the stator arrangement with coils, cam sleeve and switches.

Fig 3. Shows an end-on view of shaft and cam inside cam sleeve showing operation of the switches.

Fig 4. is a detail of the switching mechanism, and

Fig 5. is a circuit diagram of the switching mechanism.

An electric motor comprises a rotor, (Fig 1) made up of a permanent magnet 1) mounted on a shaft 2) on which is mounted a cam 3), and a stator (Fig 2) made up of a plurality of coils 4) electrically connected to a cam sleeve 5). A plurality of switches 6) project from the inside of the cam sleeve 5). When the machine is assembled (Fig 3) the shaft 2) and cam 3) rotate within the cam

sleeve 5) such that the switches 6) are depressed through 180 degrees of rotation by the cam 3), and not depressed for the other 180 degrees. The switches 6) are connected to bipolar leaf switches 7). When the switch 6) is depressed, it moves the leaf switches 7), displacing them from contact with the first pair of contacts 9) and making contact with the second pair of contacts 8). The contacts 8,9) are electrically connected to the coils 4) such that when the leaf switches 7) are connected to the first pair of contacts 9) the current flows through the coil 4) in one direction, and when the leaf switches 7) are connected to the second pair of contacts 8) the current flows through the coil 4) in the opposite direction.

Furthermore the cam 3) is mounted on the shaft 2) such that the switches 6) are depressed when the permanent magnet 1) is lined up with the coil 4) such that there is no voltage generated, or current flowing, in the coil 4). This arrangement maximises efficiency and minimises sparking.

In alternative embodiments of the invention the cam or cams are replaced by a system of gears or flanges and the like.

It should also be noted that although the embodiment described is a permanent magnet DC motor, the invention

could equally well be applied to a DC switched reluctance machine, in which the cam switches the current on as a rotor pole approaches a stator pole and coil, and switches the current off as a rotor pole becomes fully engaged with a stator pole and coil.

This configuration has the advantage of extremely low manufacturing cost, as the machine requires neither drive electronics or permanent magnets.

It should be noted that the invention can also be applied to switched reluctance machines.

Where in the foregoing description reference has been made to integers or elements have known equivalents then such are included as if individually set forth herein.

Embodiments of the invention have been described, however it is understood that variations, improvement or modifications can take place without departure from the spirit of the invention or scope of the appended claims.

CLAIMS:

1. A rotating electrical machine comprising:

a housing;

a shaft mounted rotatably within the housing;

a rotor fixed to the shaft and providing a magnetic field;

a stator positioned about the rotor within the housing and having a winding;

a switch mounted within the housing and having a first position for allowing current in one direction through the winding and a second position for allowing current in an opposite direction through the winding;

a mechanical activator movable with or by the shaft and acting on the switch so as to move it between the first and second positions when the winding is so aligned that current-inducing effects of the magnetic field on the winding are at or near a minimum.

2. A rotating electrical machine, in which the rotor comprises a permanent magnet, and the stator comprises a plurality of electromagnets, having no drive electronics, or electronic or electromagnetic position sensing devices.

3. A permanent magnet brushless DC electric motor, in which the rotor comprises a permanent magnet, and the stator comprises a plurality of electromagnets, having no drive electronics.

4. A permanent magnet brushless DC electric motor, in which the rotor comprises a permanent magnet, and the stator comprises a plurality of electromagnets, having no electronic or electromagnetic position sensing devices.

5. A DC Switched reluctance motor having no drive electronics, or electronic or electromagnetic position sensing devices.

6. A DC Switched reluctance motor having no electronic or electromagnetic position sensing devices.

7. A permanent magnet brushless DC electric motor, in which the rotor comprises a permanent magnet, and the stator comprises a plurality of electromagnets, in which commutation is effected by purely electromechanical means.

8. A DC Switched reluctance motor in which commutation is effected by purely electromechanical means.

9. A permanent magnet brushless DC electric motor as claimed in claim 6, in which the rotor comprises a permanent magnet, and the stator comprises a plurality of electromagnets, in which commutation is effected by means of a plurality of switches.

10. A permanent magnet brushless DC electric motor as claimed in claim 8, in which the rotor comprises a permanent magnet, and the stator comprises a plurality of electromagnets, in which commutation is effected by means of a plurality of leaf switches.

11. A DC Switched reluctance motor as claimed in claim 7, in which commutation is effected by means of a plurality of switches.

12. A DC Switched reluctance motor as claimed in claim 10, in which commutation is effected by means of a plurality of leaf switches.

13. A permanent magnet brushless DC electric motor as claimed in claim 9, in which the rotor comprises a permanent magnet, and the stator comprises a plurality of electromagnets, in which commutation is effected by means of a plurality of leaf switches activated by a cam or cams.

14. A DC Switched reluctance motor as claimed in claim 11, in which commutation is effected by means of a plurality of leaf switches activated by a cam or cams.

15. A permanent magnet brushless DC electric motor as claimed in claim 9, in which the rotor comprises a permanent magnet, and the stator comprises a plurality of electromagnets, in which commutation is effected by means of a plurality of leaf switches activated by a system of gears.

16. A DC Switched reluctance motor as claimed in claim 11, in which commutation is effected by means of a plurality of leaf switches activated by a system of gears.

17. A DC Switched reluctance motor substantially as hereinbefore described with reference to the accompanying drawings.

18. A permanent magnet brushless DC electric motor substantially as hereinbefore described with reference to the accompanying drawings.

19. A rotating electrical machine as hereinbefore described with reference to the accompanying drawings.

ABSTRACT

ELECTRIC MOTOR-GENERATORS

A motor-generator comprises a rotor in the form of a permanent magnet and a stator which comprises a plurality of electromagnets (coils). The coils are all energised all the time, except when their polarities are being switched.

A means of switching the polarities of the stator electromagnets (coils), mechanically linked to the rotor, comprising a plurality of bipolar leaf switches, two per coil, arranged such that as the switch is moved from one contact to the other, the polarity of the coil is reversed. These switches may be activated by a cam mounted on the shaft. The cam spans 180 degrees, so that as the shaft rotates, the coils are energised half the time with one polarity, and half the time with the other. Furthermore, the cam is aligned with the permanent magnet such that the point at which the polarities are reversed is the point at which the permanent magnet is lined up with a given coil, such that as there is no change in flux linkage at that point, there is no voltage or current in the coil.

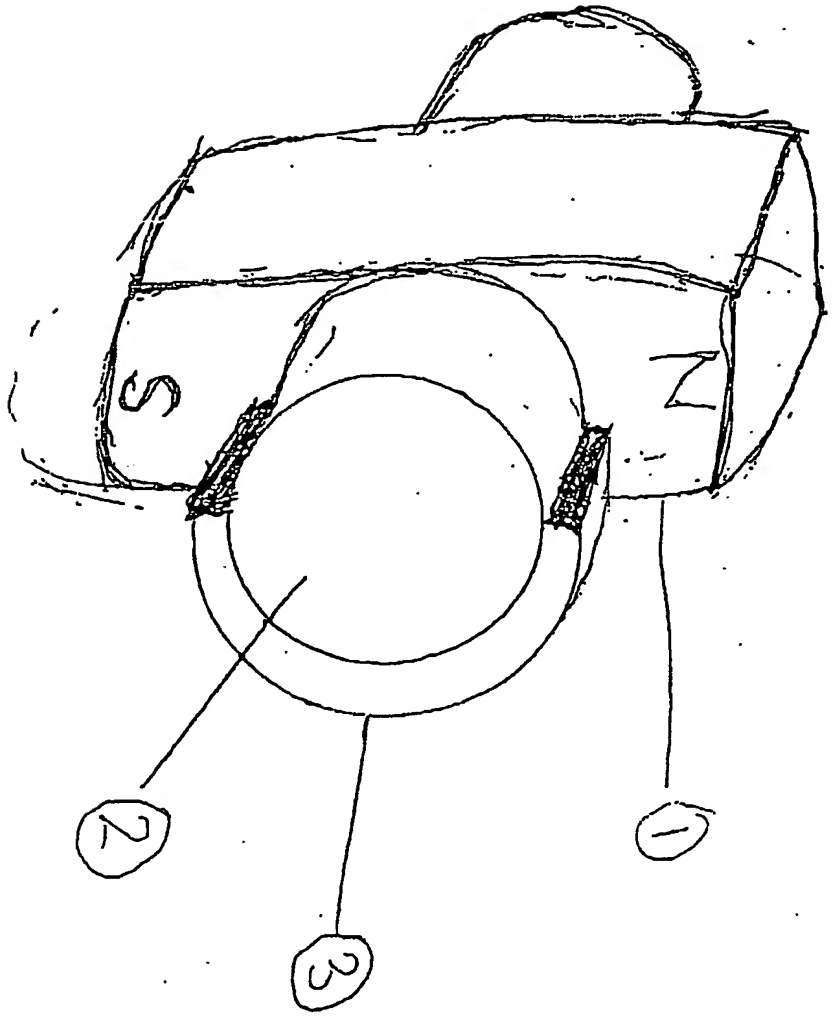

FIG 1

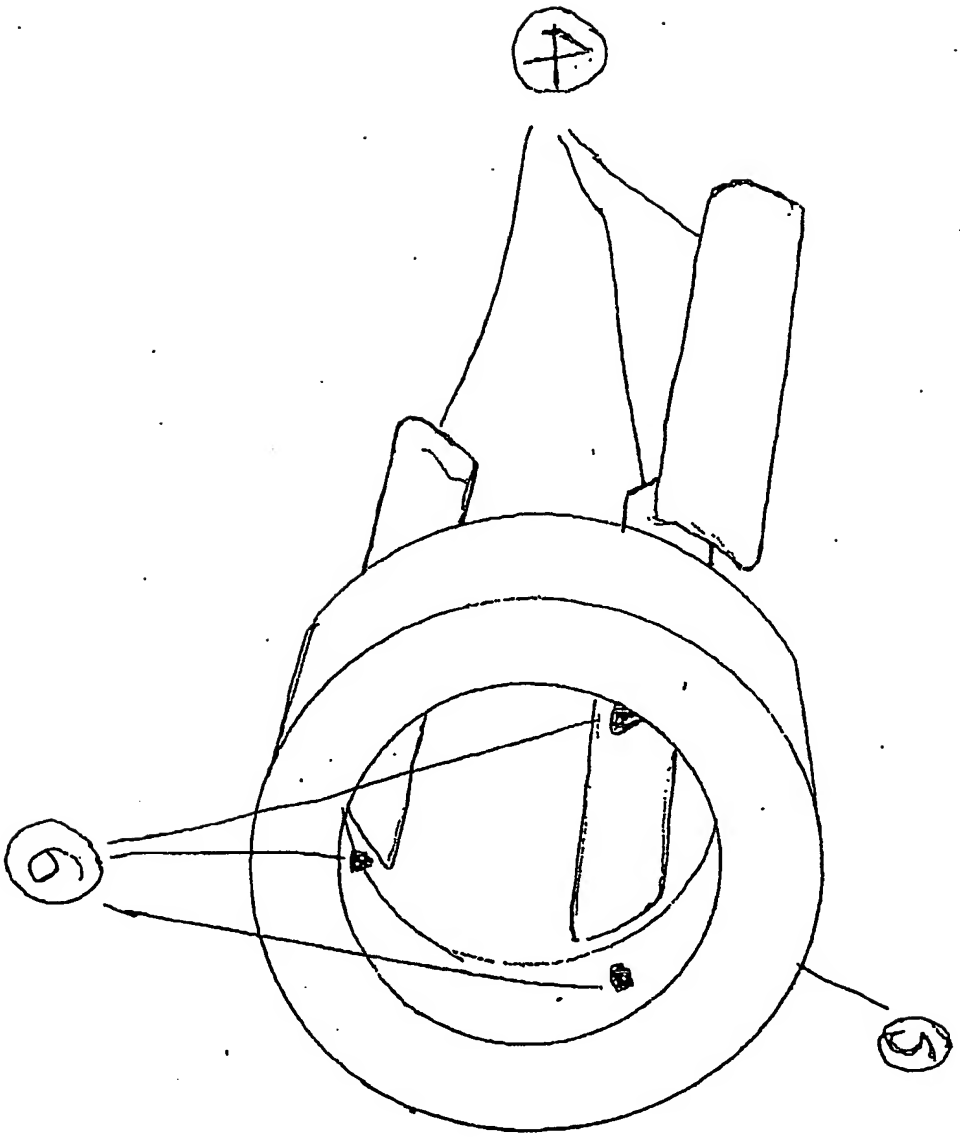

Fig 2

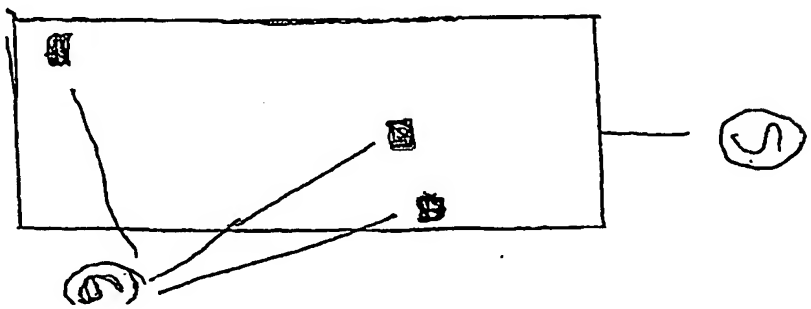

Fig 3

Replace this drawing with Ron's drawing

Needs to be.

1. Mechanically accurate
2. low mass.
3. small movement
4. mechanically damped

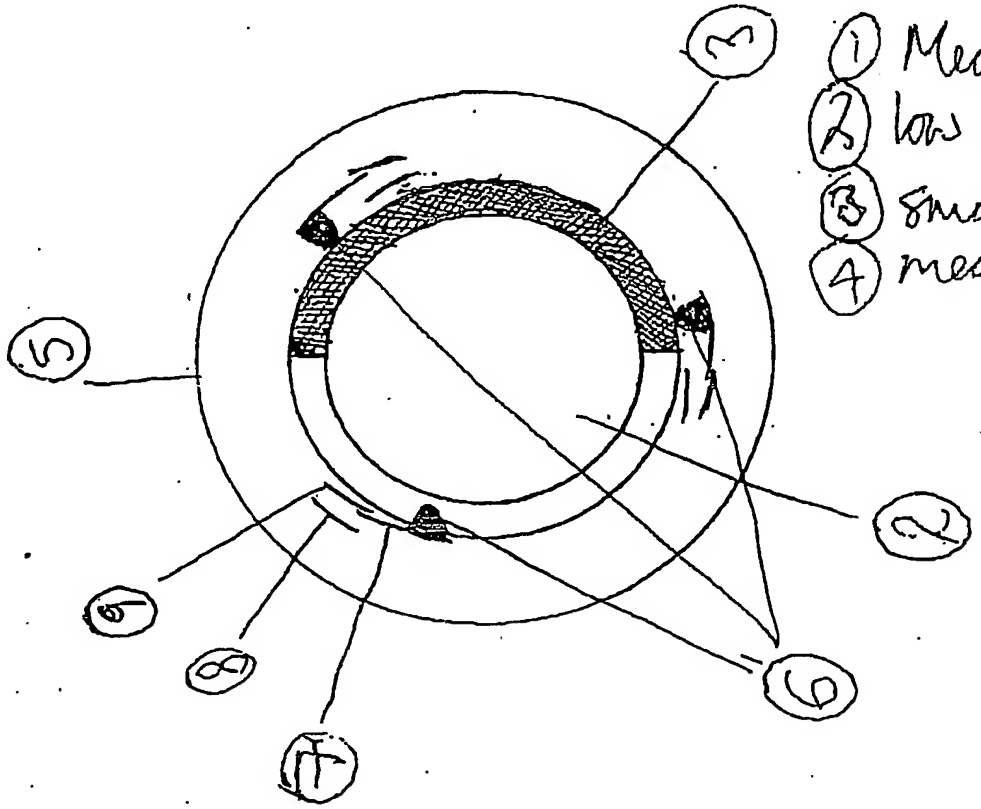

Fig 4

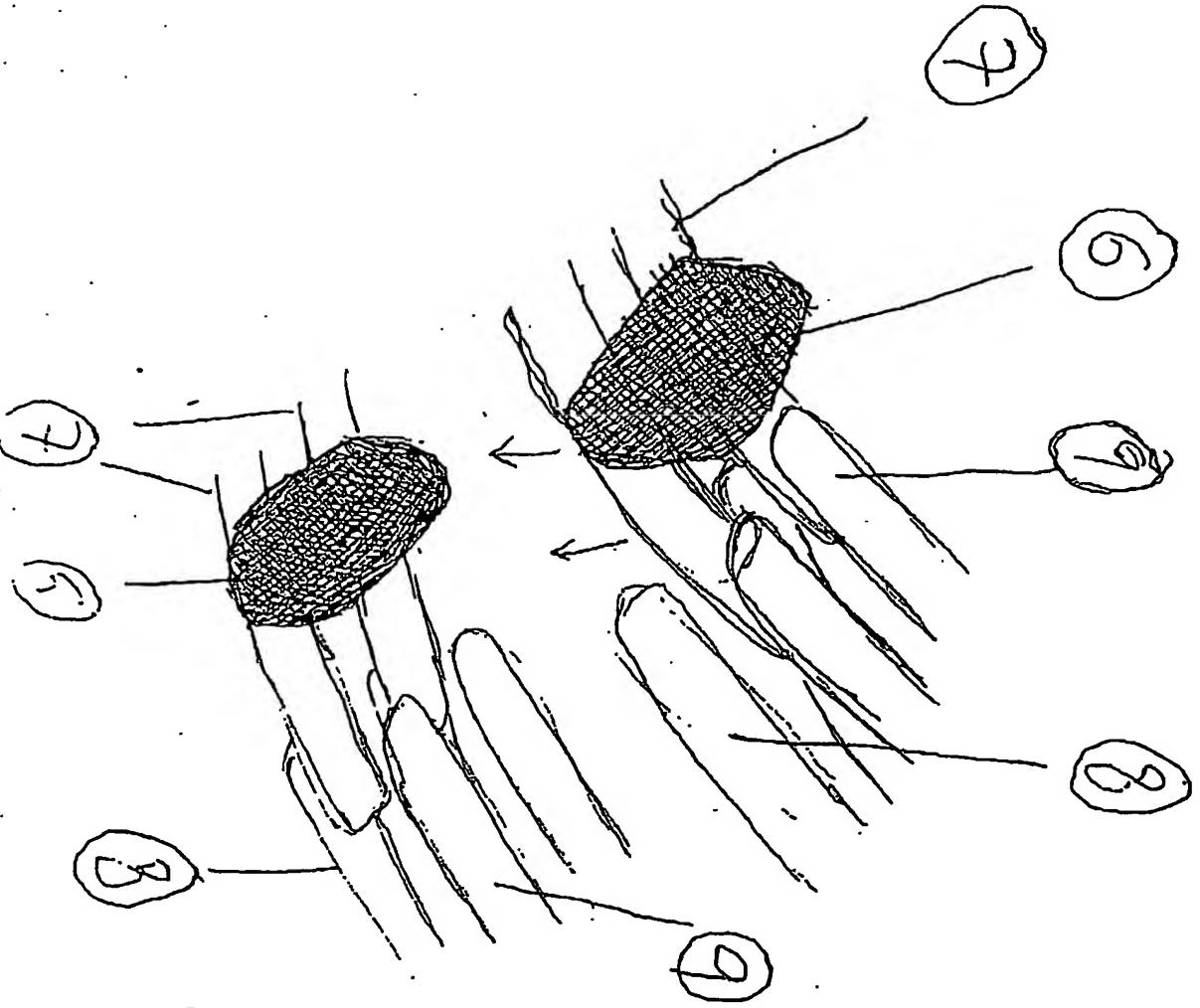

Fig ⑤